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(72) Inventor: Masao Suzuki
(72) Inventor: Yasuyuki Yamazaki
(71) Applicant: CANON INC

SPECIFICATION

1. TITLE OF THE INVENTION
IMAGE PICKUP DEVICE

2. CLAIMES
(1) An image pickup device comprising: a first white balance adjusting unit, using a signal obtained from an image pickup element to generate a control signal for white balance adjustment; a second white balance adjusting unit, using a signal obtained from a colorimetric sensor to generate a control signal for white balance adjustment; and a synthesizing unit, changing a synthesis ratio of the respective control signals according to a difference between the signal obtained from the image pickup element or a signal equivalent thereto and the signal obtained from the colorimetric sensor.
(2) The image pickup device according to Claim 1, comprising: the first white balance adjusting unit, using the signal obtained from the image pickup element to generate the control signal for white balance adjustment; the second white balance adjusting unit, using the signal obtained from the colorimetric sensor, having a field angle different from an image pickup field angle of an image pickup optical system, to generate the control signal for white balance adjustment; and a synthesizing unit, changing and then outputting the two control signals upon comparing an output of a photometric unit, differing from the colorimetric sensor, and an output from the colorimetric sensor.
(3) The image pickup device according to Claim 2, wherein the photometric unit has a photometric field angle that is substantially the same as the image pickup field angle of the image pickup optical system.
(4) The image pickup device according to Claim 2, wherein the photometric unit has a photometric field angle that is narrower than the image pickup field angle of the image pickup optical system.

(5) The image pickup device according to Claim 2, wherein the photometric unit uses the image pickup element.

3. DETAILED DESCRIPTION OF THE INVENTION

[Industrial Field of Application]

The present invention relates to an image pickup device, in particular, an image pickup device including a white balance adjusting unit.

[Prior Art]

As conventional white balance adjusting devices of image pickup devices, there is an external measurement system, such as shown in FIG. 7, which performs white balance adjustment according to an output signal from an external colorimetric sensor, and a through-the-lens system (hereinafter referred to as "TTL system"), such as shown in FIG. 8, which performs white balance adjustment according to an output signal from an image pickup element. The conventional examples shall now be described using FIGS. 7 and 8.

FIG. 7 is a block diagram of a conventional example of an external measurement system, and 1 is a solid-state image pickup element, which is an image pickup element that converts light information to an electrical signal. 2 is a luminance signal processing unit, performing an appropriate process on an output of the image pickup element 1 to derive a luminance signal Y. 3 is a saturation signal processing unit (hereinafter referred to as the "chroma signal processing unit"), performing an appropriate process on the output of the image pickup element 1 to derive a low-frequency luminance signal YL and color signals R and B. 4 and 5 are an R gain controller and a B gain controller, respectively controlling levels of the outputs R and B of the chroma signal processing unit 3 to output R1 and B1. 6 is a differential amp, deriving a color difference signal R-Y from YL and R1. 7 is a differential amp, deriving a color difference signal B-Y from YL and B1. 8 is a modulating unit, deriving a modulation signal, defined by NTSC, PAL, etc., from the color difference signals R-Y and B-Y. 9 is an adder, deriving a prescribed video signal from the output Y of the luminance signal processing unit 2 and an output of the modulating unit 8. 10 is a color temperature sensor, which is a colorimetric sensor other than the image pickup element and measures a color temperature of a light source illuminating a subject, and 11 is a control voltage deriving unit, deriving, from an output of the color temperature sensor 10, voltages that control amp gains of the R gain controller 4 and the B gain controller 5.

Operations shall now be described according to FIG. 7.

From the output of the image pickup element 1, the Y signal is derived by the luminance signal processing unit 2 and YL, R, and B are obtained by the chroma signal processing unit 3. The color temperature of the light source light illuminating the subject is measured by the color temperature sensor 10, the control voltages to be

provided to the R gain controller 4 and the B gain controller 5 to correct the white balance are derived by the control voltage deriving unit 11, and the color signals R1 and B1 that are adjusted in white balance are obtained by the R gain controller 4 and the B gain controller 5. Thereafter, the prescribed video signal that is adjusted in white balance is derived from Y, YL, R1 and B1 by the differential amps 6 and 7, the modulating unit 8, and the adder 9.

Next, FIG. 8 is a block diagram of a conventional example of a TTL system, and blocks 1 to 9 correspond to blocks of the same numbers of the conventional example of FIG. 7, and 12 and 13 are low-pass filters or other averaging units that respectively average and convert the R-Y and B-Y signals to DC potentials. 14 is a control voltage deriving unit, deriving, from the signals averaged by the averaging units 12 and 13, control voltages to be provided to the R gain controller 4 and the B gain controller 5 to correct the white balance.

Operations shall now be described.

Operations of the blocks 1 to 9 are the same as those of the conventional example of FIG. 7. At the control voltage deriving unit 14, the R-Y and B-Y signals, averaged over a single image plane or a plurality of image planes by the averaging units 12 and 13, are compared with specific potentials corresponding to zero levels of the color difference signals and determined as being lower or higher in level than the zero levels, and control voltages for making the R-Y and B-Y levels be closest to the zero levels are derived. The control voltages are then input into the R and B gain controllers 4 and 5 to perform white balance adjustment.

Besides the above two systems, there is also known an example of an addition system that combines the external measurement system and the TTL system.

FIG. 9 is a block diagram showing an example of the addition system.

In this figure, blocks 1 to 14 are equivalent to the blocks of the same numbers of the above conventional examples of FIGS. 7 and 8. Hereinafter, 14 shall be referred to as a first control voltage deriving unit, and 11 shall be referred to as a second control voltage deriving unit. 27 and 28 are adders adding the control voltage, obtained at the first control voltage deriving unit 14, and the control voltage, obtained at the second control voltage deriving unit 11, at fixed proportions. White balance adjustment is performed using the added voltages.

That is, this conventional example is configured to perform better white balance adjustment by adding both the signal obtained from the image pickup element 1 and the signal from the color temperature sensor, which is the colorimetric sensor 10 other than the image pickup element, at fixed proportions.

Also, Japanese Published Unexamined Application No. S63-314424, applied for by the present applicant, also contains a description of detecting a light amount incident on a colorimetric sensor and selecting one of two colorimetric systems according to a detection output of the colorimetric sensor to perform white balance

adjustment.

[Problems to be Solved by the Invention]

However, of the above conventional examples, with the external measurement system of FIG. 7, when a main unit of the image pickup device and the subject are far apart from each other and light sources illuminating these differ or in a sunset glow situation, etc., the white balance adjustment is significantly lowered in precision.

Also, with the TTL system of FIG. 8, when a large area of the subject is of a chromatic color and in other cases where a large portion of an image plane is occupied by a single color, lowering of white balance adjustment precision occurs due to a tendency to correct the single color to white.

On the other hand, although the addition system of FIG. 9 is aimed at improving the precision by simply adding the control voltages derived by each of the external measurement system and the TTL system to compensate the demerits of the two aforementioned conventional examples, due to the addition, white balance adjustment is oppositely made lower in precision in scenes suited to each of the two systems. Furthermore, the example described in Japanese Published Unexamined Application No. S63-314424 is a relief means just for cases of dark surroundings and is not suited for white balance adjustment for bright scenes with which the system has difficulty.

An object of the present invention is to provide an image pickup device that resolves the above problems of the conventional art and is enabled to perform appropriate white balance even in image pickup under distant view, varying illumination, backlight ray, and dark background conditions, which are unsuitable for an external measurement system as well as in image pickup of cases where a picked up image plane is of a single color, which are unsuitable for a TTL system, and yet provides appropriate effects that differ from adjustment by the addition system, with which the characteristics of the aforementioned two systems are diluted.

[Means for Solving the Problems]

To achieve the above object, the present invention provides an image pickup device including: a first white balance adjusting unit, using a signal obtained from an image pickup element to generate a control signal for white balance adjustment; a second white balance adjusting unit, using a signal obtained from a colorimetric sensor to generate a control signal for white balance adjustment; and a synthesizing unit, changing a synthesis ratio of the respective control signals according to a difference between the signal obtained from the image pickup element or a signal equivalent thereto and the signal obtained from the colorimetric sensor.

Furthermore, to achieve the above object, the present invention provides a configuration including: the first white balance adjusting unit, using the signal obtained from the image pickup element to generate the control signal for white balance adjustment; the second white balance adjusting unit, using the signal obtained from the

colorimetric sensor, having a field angle different from an image pickup field angle of an image pickup optical system, to generate the control signal for white balance adjustment; and a synthesizing unit, changing and then outputting the two control signals upon comparing an output of a photometric unit, differing from the colorimetric sensor, and an output from the colorimetric sensor.

[Action]

With the above configurations, the control signal for white balance adjustment, obtained by the first white balance adjusting unit, and the control signal for white balance adjustment, obtained by the second white balance adjusting unit, are changed in synthesis ratio by the synthesizing unit according to the difference between the signal obtained from the image pickup element or the signal equivalent thereto and the signal obtained from the colorimetric sensor to output the control signal for white balance adjustment, and image pickup is performed with appropriate white balance adjustment being performed according to the output control signal.

Here, because a large difference between the respective control signals is due to an image pickup condition at the image pickup element, such as a brightness of a subject, differing greatly from an image pickup condition at the colorimetric sensor, by generating the white balance adjustment control signal using such a comparison result, more accurate white balance control is realized.

[Embodiment]

[First Embodiment]

FIG. 1 is a block diagram showing a first embodiment of an image pickup device according to the present invention.

Blocks 1 to 14 are blocks equivalent to the blocks of the same numbers described with the conventional examples.

Image pickup light is made incident on the image pickup element 1 via an image optical system 1a, and an image pickup field angle is set appropriately in the image pickup optical system 1a. 15 and 16 are switches, 17 is a switch control signal deriving unit, deriving a signal that switches the switches 15 and 16, and 18 is a photometric sensor, measuring a brightness of a subject and being disposed separately from the image pickup optical system 1a and the color temperature sensor 10, which is the colorimetric sensor.

A white diffuser plate 10a or other optical unit is positioned on a front surface of the color temperature sensor 10 and a field angle of the sensor 10 is thereby set wider than the image pickup field angle of the image pickup optical system 1a. Because the image pickup light made incident via the image pickup optical system 1a is extracted, for example, by a half mirror, etc., and made incident on the photometric sensor 18, a field angle of the sensor 18 is made a photometric field angle that is substantially the same as the image pickup field angle of the image pickup optical system 1a to enable luminance information in an image pickup range of the subject to be output more

accurately. The photometric field angle of the sensor 18 may be made narrower than the image pickup field angle.

FIG. 2 is a diagram for describing the switch control signal deriving unit 17, and 19 is a comparator and 20 is an adder.

A first white balance adjusting unit is constituted of the image pickup element 1, the averaging units 12 and 13, and the control voltage deriving unit 14, and a second white balance adjusting unit is constituted of the color temperature sensor 10, which is the colorimetric sensor other than the image pickup element, and the control voltage deriving unit 11. A synthesizing unit is constituted of the switch control signal deriving unit 17 and the switches 15 and 16.

In the present embodiment, a synthesis ratio of the control signals from the respective adjusting units is changed to 0 or 100% by the synthesizing unit of the present invention.

Next, operations shall now be described.

In FIG. 1, the operations of 1 to 14 are the same as those of the conventional example. The output Y of the photometric sensor 18 and a signal Yc, which, among the outputs of the color temperature sensor 10, expresses luminance information, are input into the switch control signal deriving unit 17. Here, Yc is an output corresponding to a green component of the light source light or is a signal etc., with which a red component, a blue component, and the green component are mixed at an appropriate ratio.

Because as mentioned above, the color temperature sensor 10 and the photometric sensor 18 differ in field angle, the output of the switch control signal deriving unit 17 is set so that when the output of the color temperature sensor 10 and the output of the photometric sensor 18 differ greatly and it can thus be deemed that light illuminated onto the subject and light illuminated onto the image pickup device are of separate light sources, the switches 15 and 16 are connected to the TTL side, which is the first white balance adjusting unit, to perform white balance control based on the image pickup light from the subject, and when the difference between the outputs is within a fixed level, the switches 15 and 16 are connected to the external measurement side, which is the second white balance adjusting unit.

An operation of the switch control signal deriving unit 17 shall now be described by way of FIG. 2. The photometric sensor output Y is input into a non-inverted input terminal of the comparator 19, and Yc+E, with which a specific value E is added to the color temperature sensor output Yc, is input into an inverted input terminal. Consequently, if

$$Y>Yc+E,$$

the output of the switch control signal deriving unit 17 is of a high level, and if

$$Y<Yc+E,$$

the output is of a low level.

To perform white balance adjustment, the switches 15 and 16 select the TTL system, which is the first white balance adjusting unit, that is, select the outputs of the control voltage deriving unit 14 as control voltages when the output of the switch control signal deriving unit 17 is of the high level, and select the external measurement system, which is the second white balance adjusting unit, that is, select the outputs of the control voltage deriving unit 11 when the output of the switch control signal deriving unit 17 is of the low level.

In addition, another example of the switch control signal deriving unit 17 shall now be described by way of FIG. 3. 21 is a comparator of the same configuration as 19 of the previous example, 22 is an adder of the same configuration as 20 of the previous example, 23 is a NAND gate, and 24 is an inverter.

In this case, if

$Yc-E<Y<Yc+E$,

the output of the inverter 24 is of the low level and the second white balance adjusting unit is selected, and if

$Yc-E>Y$ or $Yc+E<Y$,

the output of the inverter 24 is of the high level and the first white balance adjusting unit is selected.

Also, in the above example, because when $Yc-E\approx Y$ or $Yc+E\approx Y$, the change of system occurs frequently, the comparators 19 and 21 may be provided with hysteresis characteristics.

With the above configuration and operation, because white balance adjustment is performed upon selecting the control signals from the first white balance adjusting unit under great distance or backlight ray conditions, etc., in which the subject and the image pickup device are influenced by different light sources or the subject and its surroundings differ in brightness circumstances and the output of the photometric sensor is high, and selecting the control signals from the second white balance adjusting unit when the subject and the image pickup device are illuminated by the same light source or when the brightness states of the subject and its surroundings are in the same circumstances, etc., appropriate white balance adjustment can be performed under various illumination conditions.

By making an incidence angle of the photometric sensor 18 substantially the same as or narrower than an incidence angle of the image pickup optical system 1a, an image pickup device providing an even more appropriate white balance adjusting effect can be provided.

Also, by providing a switching operation point of the first and second white balance adjusting units with a hysteresis effect, a stable white balance adjusting control signal can be output and stable image pickup can be performed even near the switching point.

(Second Embodiment)

FIG. 4 is a block diagram of a second embodiment of an image pickup device according to the present invention, and 1a, 1 to 10, 12, 13, and 18 are blocks equivalent to the blocks of the same symbols in FIG. 1 of the first embodiment. 25, 26, and 27 are A/D converters, 28 is a D/A converter, and 29 is a microcomputer. The first white balance adjusting unit is constituted of the image pickup element 1, the averaging units 12 and 13, and the A/D converter 26, the second white balance adjusting unit is constituted of the color temperature sensor 10, which is the colorimetric sensor other than the image pickup element, and the A/D converter 25, and the synthesizing unit is constituted of the microcomputer 29.

FIG. 5 is a flowchart for describing an operation of the microcomputer 29 shown in FIG. 4. Operations of the second embodiment shall now be described using FIGS. 4 and 5.

First, a threshold value (threshold level) for level judgment is set as E=E1 (step (a)). Next, the output Yc of the color temperature sensor 10 and the output Y of the photometric sensor 18 are then A/D converted by the A/D converters 25 and 27 and input into the microcomputer 29 (step (b)). Then, in step (c), whether or not $Y<Yc+E$ is checked and in step (d), whether or not $Y>Yc-E$ is checked and if both is Yes, step (e) is entered to A/D convert and input the output Cc of the color temperature sensor 10 and then in step (f), the white balance control signal voltages are derived from Cc and output to the D/A converter 28. Then, in step (g), E is set equal to E2. Here, $E2>E1$.

If in step (c) or (d), $Y\geq Yc+E$ or $Y\leq Yc-E$, step (h) is entered to A/D convert and input the outputs of the averaging units 12 and 13 into the microcomputer 29, and then the white balance control signal voltages are derived and output to the D/A converter 28. Then in step (j), E is set equal to E3. Here, $E3< E1$. The signals input into the D/A converter 28 are converted to analog signals and transmitted to the R and B gain controllers 4 and 5 to perform appropriate white balance adjustment.

With the above, white balance adjustment is performed upon selecting the first white balance adjusting unit when there is a large difference between the output Y of the photometric sensor 18 and the output Yc of the color temperature sensor 10, and selecting the second white balance adjustment unit when Y and Yc are close in value, and because by making $E2>E1>E3$, a hysteresis can be provided so that even when $|Y-Yc|$ fluctuates near E1 or E2 or E3, this does not have an influence on selection of the white balance system, stable white balance adjustment can be performed even near the switching point of the first and second white balance adjusting units.

(Third Embodiment)

Although in the embodiments described above, a predetermined process is performed directly on the output of the image pickup element 1, the output of the image pickup element 1 may instead be stored in an image memory once and the process may be performed on the stored output. FIG. 6 shows such an embodiment, with 30 being a frame memory. In this case, processing according to each image plane unit is

facilitated and improvement of white balance adjustment precision can be anticipated.

(Fourth Embodiment)

Although in the embodiments described above, the R-Y and B-Y signals are used as the color signals used in the first white balance adjusting unit, R, G, and B signals, etc., may be used instead as the color signals. In this case, further improvement of the white balance adjustment effect is possible.

(Fifth Embodiment)

Also, although in the embodiments described above, the control signal, obtained by averaging the color signals of an entire image plane of the TTL system, is determined as the signal to be used in the first white balance adjusting unit, the control signal may be obtained using another method, such as by using just color signals of a high luminance portion.

(Sixth Embodiment)

Although in the embodiments described above, the selection between the first or the second white balance adjusting unit is switched so as to select the control signal voltages of either the TTL system or the external measurement system, near the switching threshold value (threshold), average values of the control signal voltages of the two systems, values approximating the average values, or other values that take in consideration the control voltages of two systems may be used as the control voltages so that the control voltages are switched gradually. In this case, more stable and favorable image pickup can be performed even near the threshold value.

The respective control signal voltages may be synthesized at a predetermined ratio not just near the threshold value but across the entire range of the control signal voltages.

(Seventh Embodiment)

Although in the embodiments described above, the photometric sensor that is separate from the image pickup optical system is used, the image pickup element may be used as the photometric sensor instead.

Also, although in the embodiments described above, the synthesis ratio of the synthesizing unit in the present invention is changed to 0 or 100% to selectively output the control signals, the synthesis ratio may be varied in a continuous or stepwise manner instead.

Also, although in the embodiments described above, the colorimetric field angle of the colorimetric sensor is wider in all cases, this may be reversed.

Furthermore, although in the embodiments described above, the photometric sensor 18 that is independent of the image pickup element 1 is provided, a luminance signal obtained from the image pickup element 1 may obviously be used as the output of the photometric sensor 18.

[Effects of the Invention]

As described above, because with the present invention, the control signals for

white balance adjustment, generated by the first white balance adjusting unit using the signal obtained from the image pickup element, and the control signals for white balance adjustment, generated by the second white balance adjusting unit using the signal obtained from the colorimetric sensor, are changed in synthesis ratio by the synthesizing unit according to the difference between the signal obtained from the image pickup element or the signal equivalent thereto and the signal obtained from the colorimetric sensor to output the control signal for white balance adjustment and image pickup is performed with appropriate white balance adjustment being performed by the control signal, appropriate white balance adjustment can be performed even in cases of image pickup of a subject of a single color or cases where the influence of a single color is strong, which could not be handled well with the TTL system, as well as in cases of image pickup under conditions of distant view, varying illumination, backlight rays, image pickup of an outdoor scene from indoors, dark background, etc., that could not be handled well with the external measurement system. Moreover, an image pickup device can be provided that provides an appropriate white balance effect that differs from the mediocre adjustment that dilutes the characteristics of the two systems that tends to occur with the simple addition system.

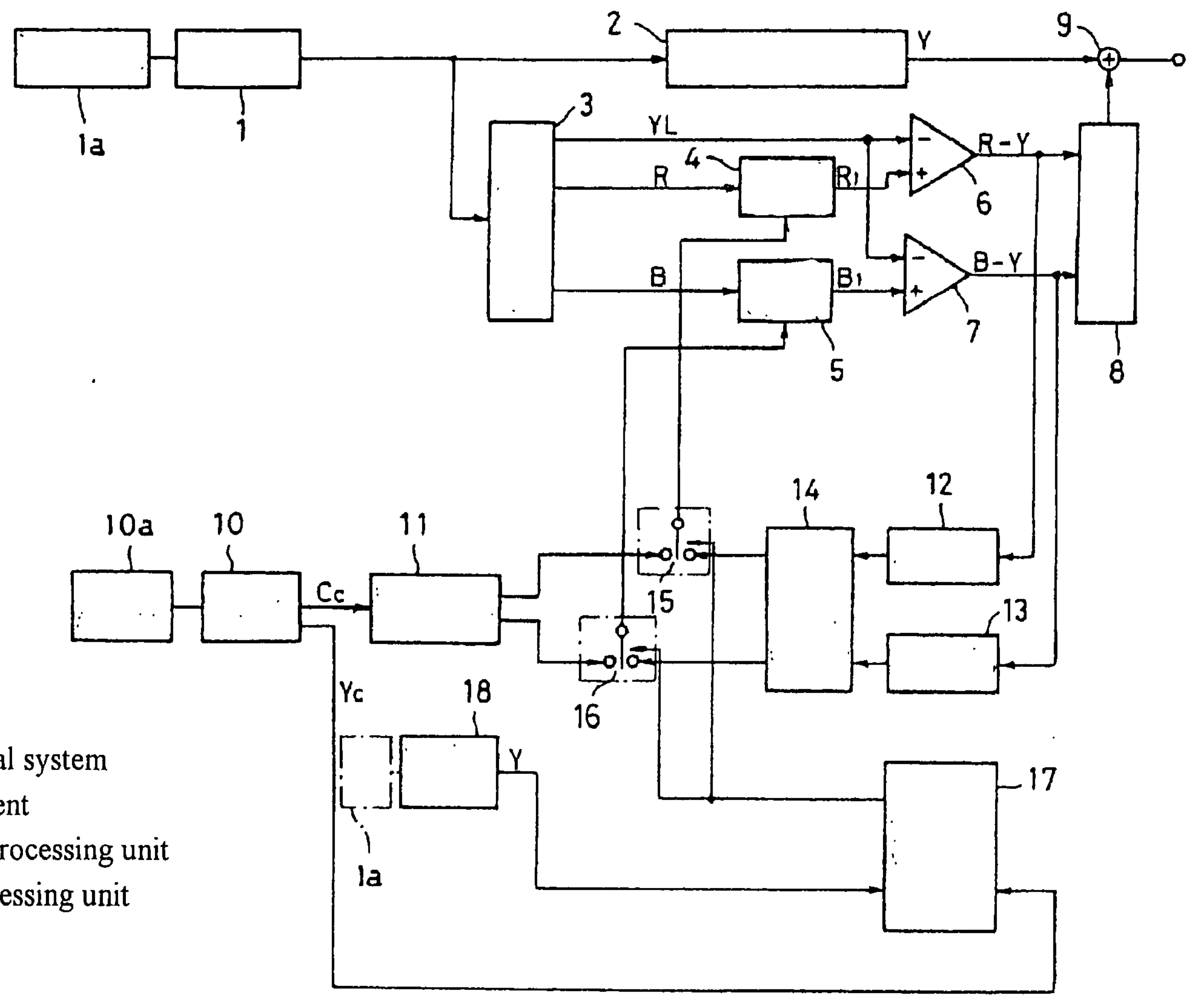
Also, with the present invention, a desired detection can be performed accurately regardless of the color, luminance, or distance of the subject, and a more accurate white balance control can thereby be realized.

By making the incidence angle of the photometric sensor substantially the same as or narrower than the incidence angle of the image pickup optical system, an image pickup system providing an even more appropriate white balance adjustment effect can be provided.

4. DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a first embodiment, FIGS. 2 and 3 are explanatory diagrams of a switch control signal deriving unit of FIG. 1, FIG. 4 is a block diagram showing a second embodiment, FIG. 5 is a flowchart for describing the second embodiment, FIG. 6 is a block diagram showing a third embodiment, and FIGS. 7, 8, and 9 are block diagrams showing conventional examples.

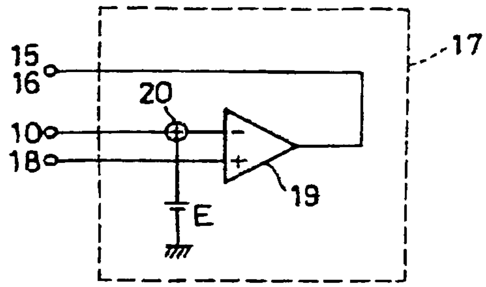
1 is an image pickup element, 2 is a luminance signal processing unit, 3 is a chroma signal processing unit, 4 and 5 are, respectively, an R gain controller and a B gain controller, 6 and 7 are differential amps, 8 is a modulating unit, 9 is an adder, 10 is a color temperature sensor, which is a colorimetric sensor, 11 and 14 are control voltage deriving units, 12 and 13 are averaging units, 15 and 16 are switches, 17 is a switch control signal deriving unit, 18 is a photometric sensor, 19 and 21 are comparators, 20 and 22 are adders, 23 is a NAND gate, 24 is an inverter, 25, 26, and 27 are A/D converters, 28 is a D/A converter, 29 is a microcomputer, and 30 is a frame memory.



1a	Image pickup optical system
1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
10a	White diffuser plate
10	Color temperature sensor
11	Control voltage deriving unit
12	Averaging unit
13	Averaging unit
14	Control voltage deriving unit
17	Switch control signal deriving unit
18	Photometric sensor

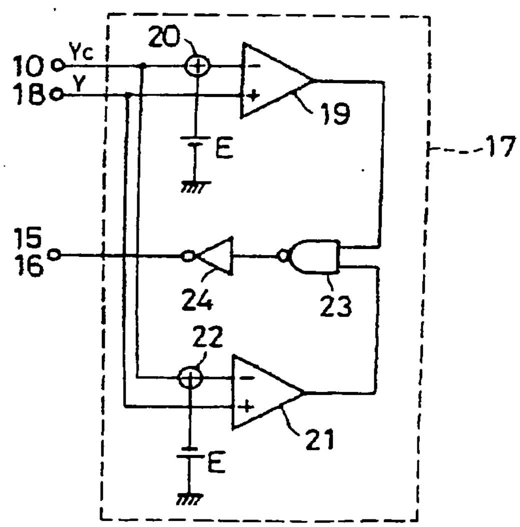
Block diagram of the first embodiment

FIG. 1



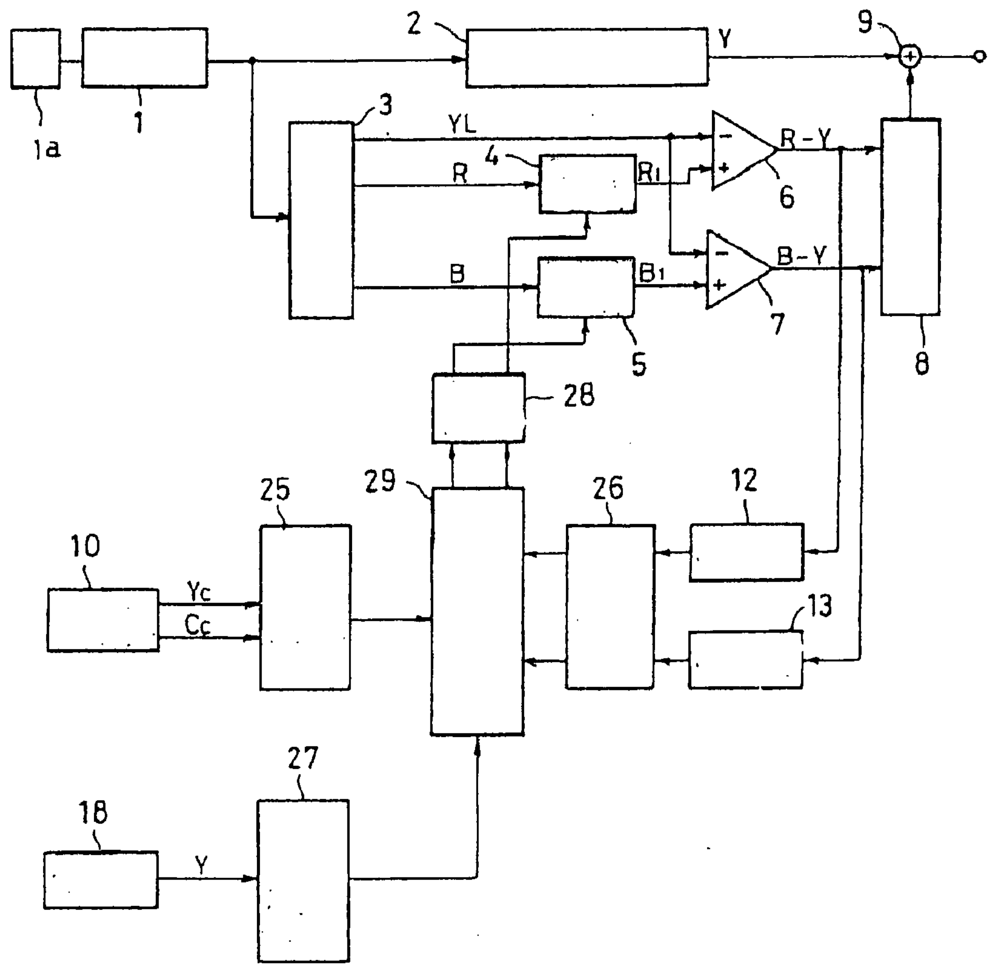
Explanatory diagram of a switch control signal deriving unit

FIG. 2



Another example of a switch control signal deriving unit

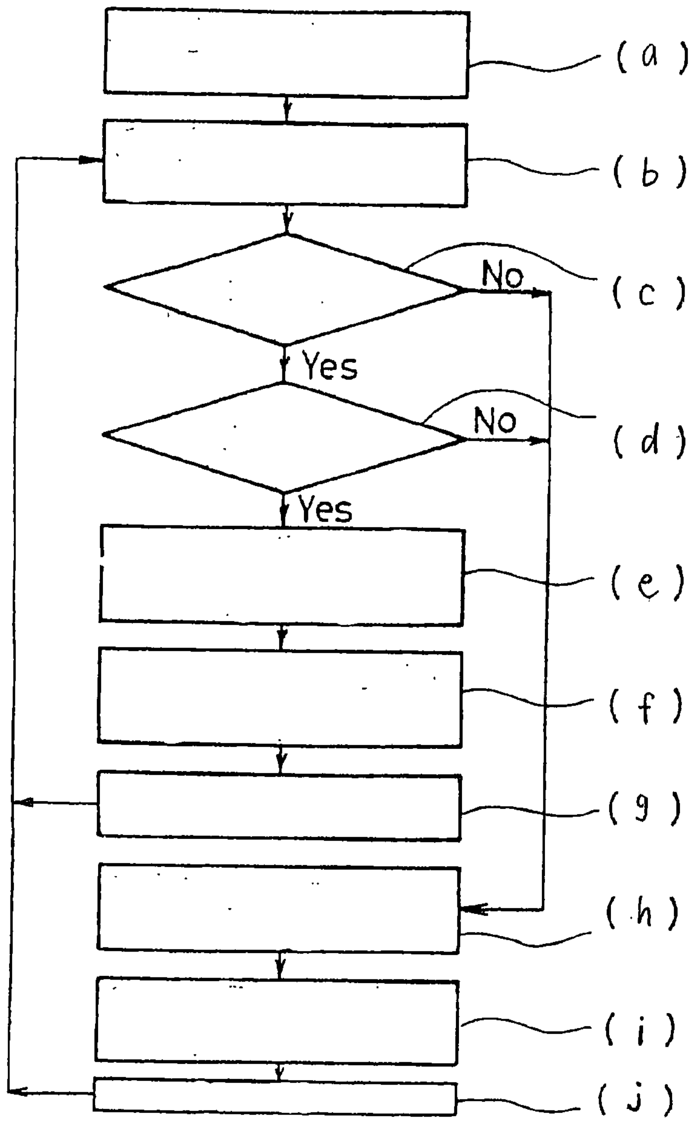
FIG. 3



1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
10	Color temperature sensor
12	Averaging unit
13	Averaging unit
18	Photometric sensor
25	A/D converter
26	A/D converter
27	A/D converter
28	D/A converter
29	Microcomputer

Block diagram of the second embodiment

FIG. 4



Flowchart of the second embodiment

[FIG. 5]

(a) Set initial value of threshold level: $E=E_1$.

(b) Input color temperature sensor output V_c and photometric sensor output V

(c) $Y<Y_c+E$?

(d) $Y>Y_c-E$?

(e) A/D-convert and input color temperature sensor output C_c

(f) Derive control voltages from C_c and output to D/A

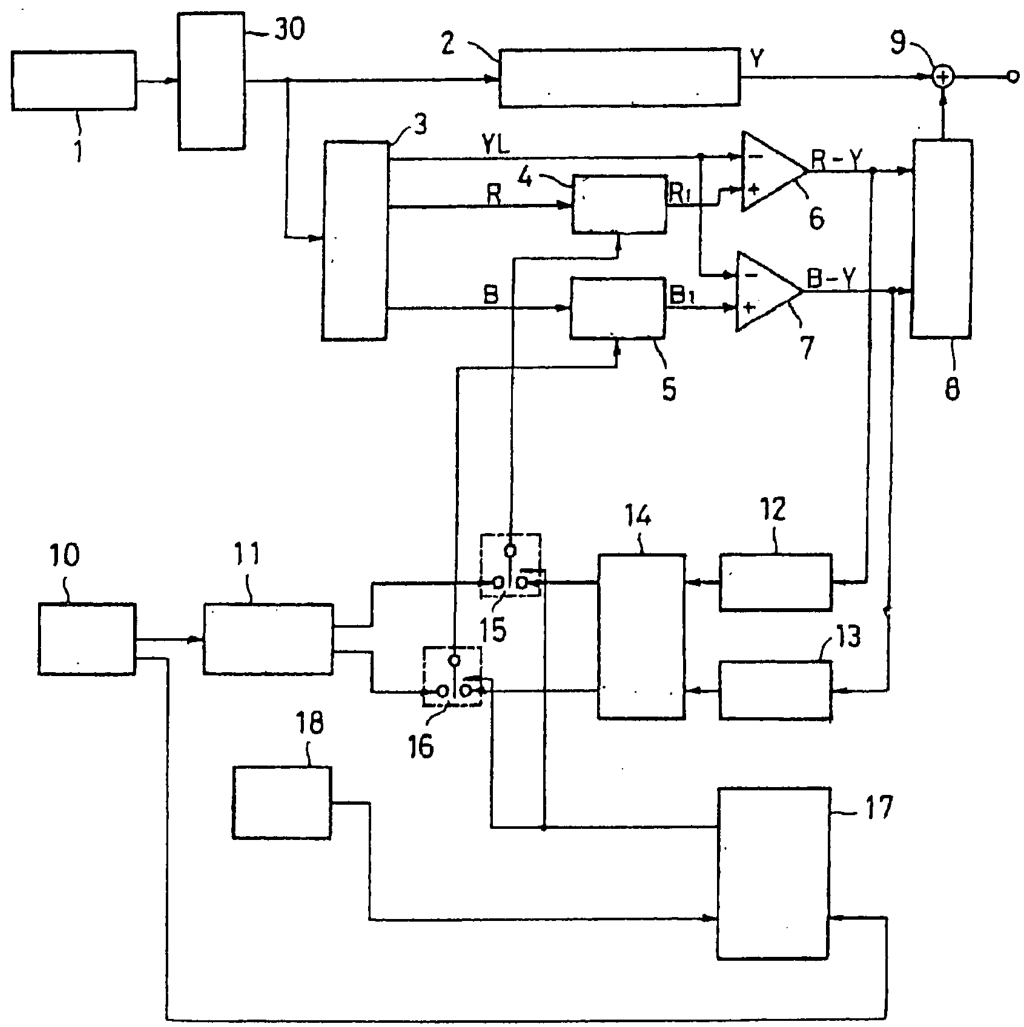
(g) $E=E_2$

(h) A/D-convert and input averaging unit outputs

(i) Derive control voltages from averaging unit outputs and output to D/A

(j) $E=E_3$

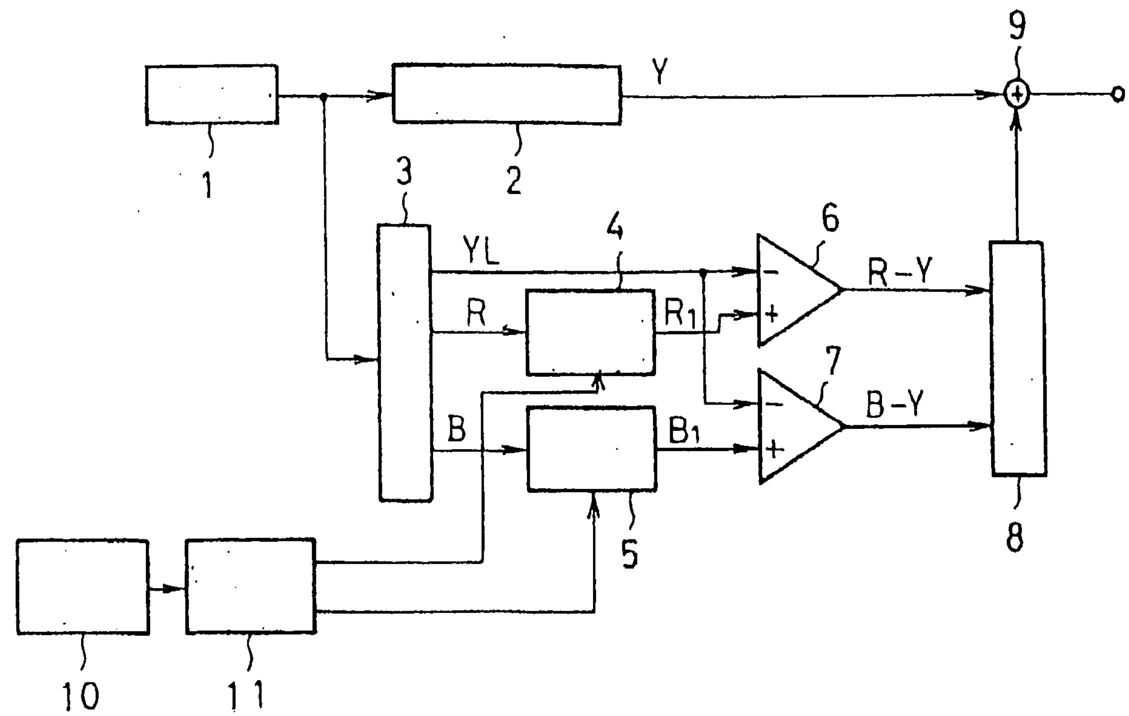
1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
10	Color temperature sensor
11	Control voltage deriving unit
12	Averaging unit
13	Averaging unit
14	Control voltage deriving unit
17	Switch control signal deriving unit
18	Photometric sensor
30	Frame memory



Block diagram of the third embodiment

FIG. 6

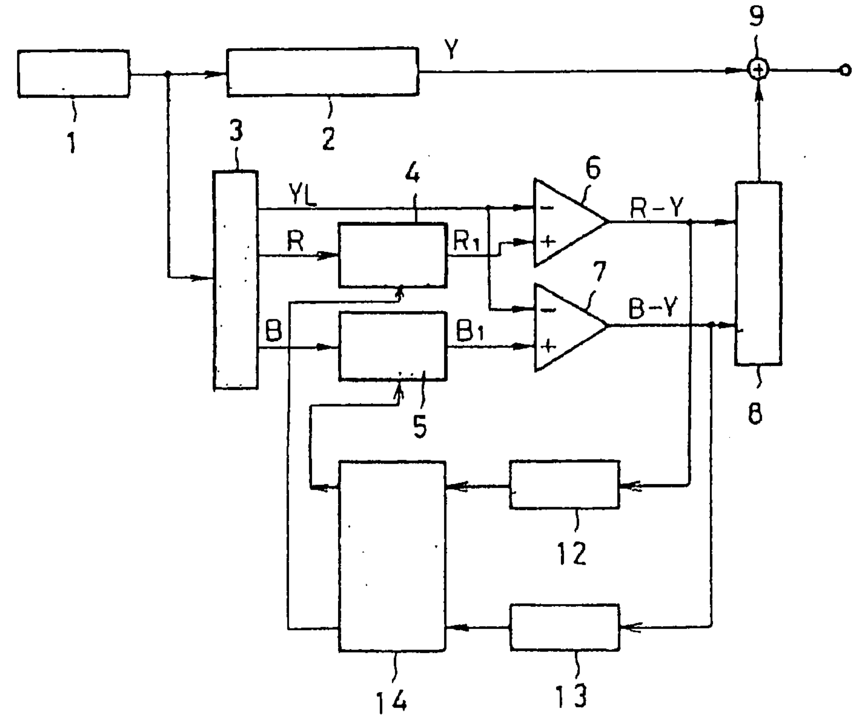
1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
10	Color temperature sensor
11	Control voltage deriving unit



Conventional example of an external measurement system

FIG. 7

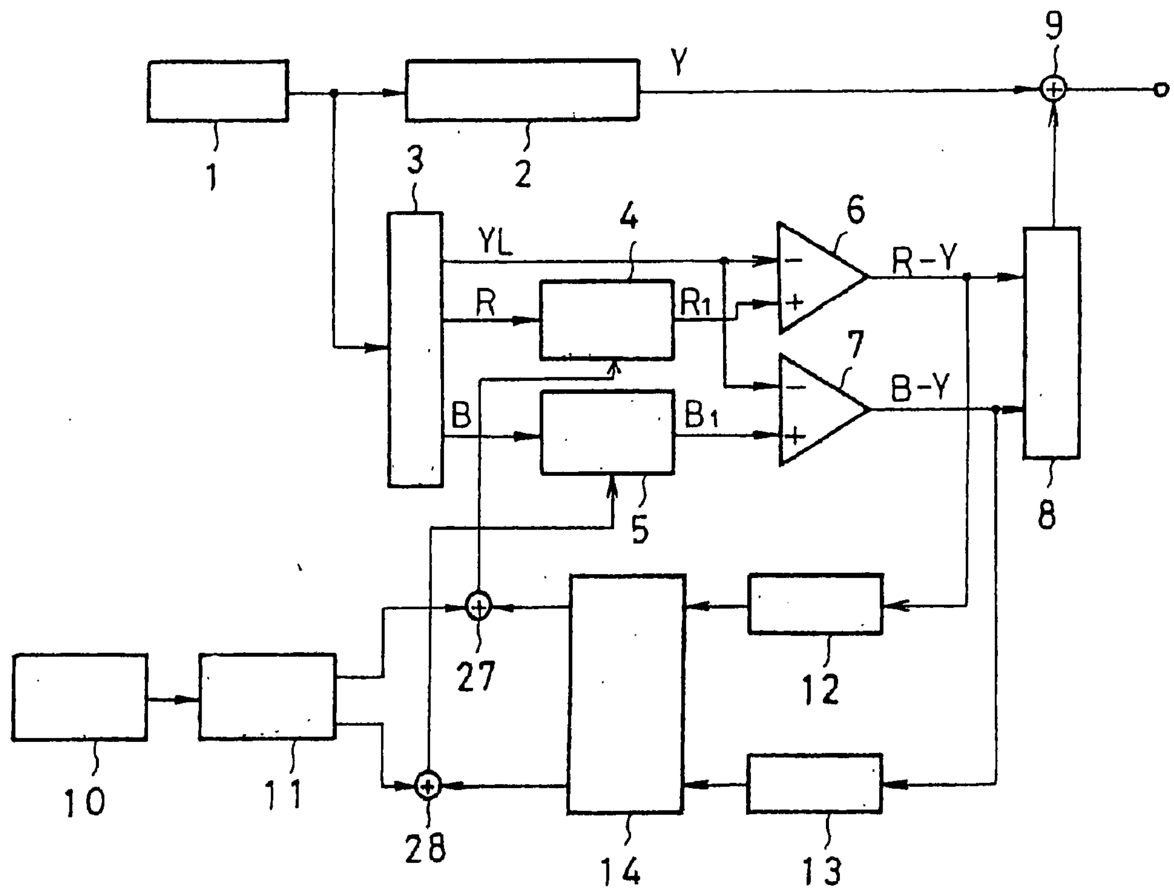
1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
12	Averaging unit
13	Averaging unit
14	Control voltage deriving unit



Block diagram of a conventional example of a TTL system

FIG. 8

1	Image pickup element
2	Luminance signal processing unit
3	Chroma signal processing unit
4	R gain controller
5	B gain controller
8	Modulating unit
10	Color temperature sensor
11	Control voltage deriving unit
12	Averaging unit
13	Averaging unit
14	Control voltage deriving unit



Conventional example combining an external measurement system and a TTL system

FIG. 9